

CLAIMS

1. A tool (101; 102) for inserting and mating two plug members (2, 3) of a sealing device (1) for closing a wound in the wall of a vessel, one plug member of the sealing device being a distal plug member (2) to be positioned inside the vessel and the other plug member being a proximal plug member (3) to be positioned outside of the vessel, and the distal plug member being provided with an elongated retracting means (6) extending from the distal plug member, characterized in that the tool comprises a gear mechanism (32; 132) coupled to the retracting means for converting a movement of the tool in a proximal direction away from the wound, when the distal plug member is anchored in the vessel, to a pushing movement for moving the proximal plug member in a direction towards the distal plug member in response to a stretching force (F_1) in the retracting means.
2. The tool (101; 102) according to claim 1, characterized in that the tool comprises a spring-biased coupling means (41; 164, 166) for releasably coupling the retracting means (6) to said gear mechanism (32; 132).
3. The tool (101; 102) according to claim 2, characterized in that the biasing force of said spring-biased coupling means (41; 164, 166) is selected to release the retracting means (6) when the stretching force (F_1) in the retracting means exceeds a selected force attributed to the rupture tension of the wall of vessel.

4. The tool (101; 102) according to anyone of claims 1 through 3,
characterized in that said tool comprises

an outer feeding means (33; 133) for pushing the proximal plug member (3), said
outer feeding means being provided with an axial through bore;

5 an inner feeding means (34; 134) for pushing the distal plug member (2), said inner
feeding means being provided with an axial through bore for moveably receiving
said retracting means (6), and said inner feeding means being disposed for
movement in said bore of said outer feeding means;

10 said gear mechanism (32; 132) being coupled to said inner feeding means and said
outer feeding means; and

15 a pushing means (36, 150) for pushing the gear mechanism (32; 132), the outer
feeding means (33; 133) and the proximal plug member (3) with respect to the
casing (30; 130) of the tool, in a direction towards the wound.

20 5. The tool (102) according to claim 4

characterized in that said gear mechanism (132) comprises

at least one of a set comprising

25 a gear rack (170a, 170b) fixed to said pushing means (150),

a cog rail (163a, 163b) connected to said outer feeding means (133),

30 a double gear wheel (168a, 168b) having a small gear ring (180) and a large gear
ring (181) fixed with respect to each other, said double gear wheel being rotatably
connected to a plate member (164),

said large gear ring (181) being in engagement with said gear rack (170a, 170b) and
said small gear ring (180) being in engagement with said cog rail (163a, 163b),

35 and said plate member (164) being arranged to move with said outer feeding means
and said plate member releasably holding the retracting means by means of a
spring (166), the retracting means being moveably disposed in the bore of said inner
feeding means,

40 said set thereby cooperatively arranged to convert a proximal movement of said tool
to a distal movement of said outer feeding means when the retracting means is
stretched.

6. The tool (101) according to claim 4
characterized in that said gear mechanism (32) comprises
a first pulley (38) attached to said outer feeding means via a spacer member (37);
a second pulley (40) attached to said inner feeding means (34);
5 a first brake means (41) attached to said inner feeding means;
a second brake means (43) attached to said pushing means (36); and
wherein the retracting means (6) is arranged such that it extends from the distal
plug member (2) in a proximal direction, through said bore of said inner feeding
means (33), through the first brake means (41), around said first pulley (38) to be
10 redirected to a distal direction, around said second pulley (38) to be redirected
again to the proximal direction, and through said second brake means (43).

7. A sealing device (1) including a distal resiliently expandable plug member (2)
having an elongated retracting means extending centrally from the distal plug
member and including a portion (10) for attaching a proximal plug member (3) of
the sealing device, the proximal plug member being resiliently expandable and
being adapted to be mounted onto the distal plug member to be fixed thereto by
means of the attaching portion,
20 **characterized in that** the distal plug member comprises a through bore (8), and a
suture (6) is passed through said bore (8) to serve as the retracting means by
providing an enlarged portion at one end as a counter when pulling the suture.

8. A system for closing a wound in a punctured vessel,
characterized in that a sealing device according to claim 7 is inserted and mated
25 by the use of a tool according to anyone of claims 1 through 6.

9. A method for closing a wound in a punctured vessel by inserting and mating two plug members (2, 3) of a sealing device (1), one plug member of the sealing device being a distal plug member (2) to be positioned inside the vessel and the other plug member being a proximal plug member (3) to be positioned outside of the vessel, and the distal plug member being provided with an elongated retracting means (6) extending from the distal plug member,

the method including the step of

- positioning the distal plug member (2) inside the vessel with the retracting means (6) being attachable to the tool;

characterized in that it comprises the steps of

- providing a tool (101; 102) comprising a gear mechanism (32; 132) connectable to the retracting means for converting a movement of the tool in a proximal direction away from the wound, to a pushing movement for moving the proximal plug member in a direction towards the distal plug member in response to a stretching force (F_1) in the retracting means when the distal plug member is anchored in the vessel; and

- withdrawing the tool (101; 102) with the retracting means attached thereto to stretch the retracting means, thereby activating the gear mechanism to approach the proximal plug member towards the distal plug member via a feeding means (34; 134).

10. The method according to claim 9,

wherein said tool (101; 102) comprises a spring-biased coupling means (41; 164, 166) for releasably coupling the retracting means (6) to said gear mechanism (32; 132).